ARUBA PHOSPHATE.

ITS OCCURRENCE, COMPOSITION AND QUALITY.

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THE West Indian island of Aruba is one of the Dutch Antilles in the Caribbean Sea, and together with Curacoa, Bonaire, St. Martin, St. Eustatia, and Saba constitutes the colony of Curacoa.

Aruba is situated about 43 miles from the N.W. point of Curaçoa, and N.E. by N. 16 miles from Cape San Roman, off the coast of Venezuela.

In a West Indian chart for 1885 it is said to be about 17 miles long S.E. and N.W.; but the entire length over land will be about 25 miles, and 5 miles broad. The population is between 6000 and 7000, of which number 4000 to 5000 are situated in the town and suburbs of Orangestadt. A corrupt Spanish is the prevailing language; (known as *papiamentoe*), possessing many of the deformities usually resulting from a mixture of races and the ungrammatical characteristics of every *patois*.

Early in the 16th century CURACOA was a Spanish settlement, but was taken by the Dutch in 1632, and after changing hands with the English was ultimately given up to Holland in 1816. The Island has a rocky and barren appearance from the sea, but possesses the most commodious and beautiful harbour of the West Indies, and is thus eminently fitted for carrying on an extensive commerce in exchanging goods from American and European ports for those of Venezuela and New Granada.

ARUBA exhibits a fertile appearance from the sea; but on closer inspection it will be seen that the rugged granite hills are only sparsely covered with trees that characterise dry, arid climates. Many beautiful specimens of the cactus family are conspicuously disseminated over most of the island, contributing very much to the interesting scenery in many places observable. Though no tropical forests or hills heavily clad with verdure exist here, the contiguity of the encircling sea, the continuous sunshine, and the salubrity of a beautiful atmosphere constitute elements of enjoyment which once experienced can never be forgotten.

The principal cattle are goats, sheep, and donkeys. The goats and sheep are kept for milk and meat, and the donkeys as beasts of burden. Goats in Aruba may be numbered by thousands, and donkeys by hundreds, but oxen and horses are rarely seen. The donkeys are generally used without bridle or bit to carry the happy possessors on their migratory journeys, at a speed rarely exceeding a walk, and more typical of laziness and unconcern than of the shortness of time and exacting industry.

The people's necessities, however, are very few, and in consequence existence seems cheap and easy compared with European life, but devoid of many of the pleasures and privileges education and refinement provide.

From the preceding it will be readily understood that Aruba is exceptionally healthy. No cholera or malarious fevers are known here; a fresh invigorating atmosphere, clear sky, and enjoyable breeze prevail almost without interruption all the year round. There is nearly always a good wind blowing from E.N.E., said to be rarely less than 10 miles per hour, which materially reduces the discomforts the high temperature would engender, and thus makes the atmosphere bracing and healthy, that would otherwise be sultry and disagreeable. On the windward side of the island the trees in unsheltered places lay over at right angles to the westward, exhibiting a bleak and stormy appearance, but their misshappen aspect is alone due to the permanency of the wind.

The temperature also is very constant, and only varies 6° or 8° between winter and summer.

During the cool season the thermometer stands about 82° in the shade during the day and 78° during the night, and throughout the hot season about 90° and 82° respectively. In the sun, however, the temperature often rises to 140° F. and sometimes higher, and Europeans have necessarily to be very careful not to expose themselves incautiously to the scorching sun, or the dangers of brain congestion, &c., soon become a reality, and mar the pleasing influences of a delicious climate of perpetual summer. The extremities of the island are level and low, but several picturesque hills rise to a considerable height in the centre. The Pan de Azucar (Sugar-loaf Hill), so named from its shape, is visible 18 or 20 miles off. Yamanota, however, is the highest hill, and rises to a height of about 600 feet.

The west side of the island is skirted by a chain of low bushy reefs, which extend from near the S.W. point to within three miles of the east end, where they terminate in a rocky islet considerably higher than the others.

About three miles westward of Sugar-loaf hill there is a projecting sandy point, and between it and the crags further westward is an opening leading into the harbour and town of Orangestadt.

The island for almost its entire length on the leeward side is skirted by a coral reef from a quarter to half a mile from the shore, within which is a calm and beautiful lagoon. Within this lagoon, at Boca St. Nicolas, the Aruba Phosphaat Maatschappy have constructed an iron pier at considerable expense to expedite loading and unloading vessels for the Phosphate Company. A belt of coral limestone surrounds the island, but the predominating rock of the interior is grey granite. Enormous detached boulders are plentifully distributed in many localities, making the scenery very picturesque and attractive. Amongst the granite hills many quartz veins containing gold have been found, of considerable value, and which, together with the phosphate deposits, constitute the principal mineral wealth of Aruba.

Deposits of mineral phosphates are extensively distributed throughout the globe, but, unlike many other minerals, the quantities found in different localities are of comparatively limited range. Gold-bearing quartz is generally distributed throughout Aruba, but the phosphate is found in quantity and satisfactory quality in one or two districts only.

Cerro Colorado is a conspicuous brown hill of considerable size at the south-east extremity, and rising to an eminence of 100 feet above the sea, and considerably above the adjoining rocks. On the south and north-west side of this hill phosphate is at present excavated by the Aruba Phosphaat Maatschappy. It is bounded by the sea on the south and north-east, and by coral limestone to the north and west. The surface is covered with brown pebbles of phosphoritic limestone, and the hill itself, destitute of vegetation, consists of an agglomeration of argillaceous rock, limestone, and phosphates. The phosphate deposits are all characterised by a want of regularity or order in their arrangement and position. No symmetry, parallel veins, or strata are to be seen, and the oddity of its occurrence is only rivalled by the endless variety of colour and appearance the phosphate assumes.

The great irregularity noticed when phosphate mining here, undoubtedly suggests to the mind some previous upheavals and disturbances, that make it difficult to identify the original agency by which the agglomeration of phosphate was brought about. What may at one time have been layers, regular and uniform, subsequent disturbances and upheavals have displaced and dislocated to such a degree that no resemblance of its primary shape remains.

Variability of colour, form, and position is a frequent characteristic of phosphate deposits wherever they occur in the consolidated form of rock. Irregular strata, slanting from the limestone below to the top of the hill, is one of the most prevailing situations; huge pockets are found sometimes, and in other places layers under the limestone and sometimes above it.

Many theories have been advanced to explain the original formation and aggregation of phosphate. Dr. Dawson, a prominent geologist, gives the following explanation, which appears acceptable.

When speaking of phosphates he says:—"There are two sources of supply, namely, the concentrated deposits of phosphatic matter, known as the guanos of South America, and the crystalline deposits of Canada, Norway, and Spain. The guanos he divides into nitrogenous and phosphatic, the former being the bird excrement occurring in the exceptionally dry climate of the South American coast, where the organic matter, converted by decomposition into ammonia salts, remains as part of the mass. The latter has been impoverished of its ammonia salts by rain and prolonged exposure, but the phosphatic material remains, such as the guanos of the West Indies. The deposits in the South of France known as Bourdeaux phosphate are of a similar nature, and may be traceable to mussel mud, or the accumulations in shallow tidal estuaries of mollusks and other marine organisms. The Aruba Phosphate, in some respects, resembles the deposits found in the Laurentian rocks of Canada, and doubtless owes its formation to similar issues.

"From the occurrence of numerous fossilised mollusks and other shells, the frequent evidence of coral insects, and other data, we are led to the inference that the sediments of phosphate are submarine or tidal accumulations that have been so completely altered by volcanic and igneous action that the present hard rocky condition in no way resembles the original, and identification is rendered more or less speculative and uncertain."

Many geologists, however, accept the preceding explanation, and consider the original sedimentary origin of Laurentian rocks to be mussel muds, sand, and coprolite layers, that have been changed by igneous, electrical, and eruptive influences to crystalline or vitreous rocks.

The Aruba Phosphate, although of variable appearance, is very regular in composition as exported. From the hill sides the rock is obtained by means of dynamite, and, as a consequence of its collection, removal, and storing, becomes thoroughly mixed and uniform. The stones are all loaded by hand and closely examined by the workmen and overseers, as a precaution against any new strike of inferior quality being incorporated with the mass. In addition to close ocular examination the quantity excavated is analysed every week by a competent analyst in the Phosphate Company's service. Whenever stones are found of different or questionable appearance, samples are submitted to the analyst and duplicates preserved for future guidance. With so much care conscientiously exercised it is not surprising the quality varies very slightly, and that manufacturers who have used it have found it admirably adapted for the production of high class manures.

When examined in bulk the phosphate has a very varied appearance. Some of it is very solid and brittle, and some soft and porous.

An almost endless variety of colour and structure may be selected—crystalline and vitreous; lamellated and pyrolitic. One class of good quality is nearly black, and some containing over eighty per cent of phosphate is nearly white. The predominant colour, however, is brown-grey running through many shades between brown and grey and yellowish brown. Many specimens possess the characteristic colour of peroxide of iron, but when examined closely the surface colouring of oxide is seen to be immeasurably thin and insignificant. The characteristic brown colour of the phosphate I believe to be due to organic matter, as the oxide of iron rarely exceeds 1·75 per cent.

In many places in the quarries the phosphate is found in large solid masses of good quality; but it occasionally happens that portions of it contain small nodules (*postemas*) of earthy phosphoritic limestone and argillaceous foreign substances, peculiarly intermingled with the phosphate of good quality. The nodules are well-defined and distinct, and allow of complete removal. The quantity is comparatively small and insignificant, but their appearance and composition is not at all incompatible with the theory that the phosphates have been originally sedimentary accumulations of submarine organisms, upon which small nodules of limestone and ferruginous earth have been distributed during gradual aggregation, and by subsequent influences the bases have become largely united with phosphoric acid.

Although the nodules in question contain from 40 to 50 per cent of phosphates, they are all carefully extracted. The greatest care is exercised, and the best testimony of the efficacy of the selection may be seen from the regularity of the analyses of every cargo shipped.

The following is an analysis by Thos. Blackburn, F.C.S., of a cargo recently shipped, and is a fair representation of the quality always exported by the Aruba Phosphaat Maatschappy:—

	Per cent.
Silica	1·60
*Phosphoric acid	36·01
Sulphuric acid	1·37
†Carbonic acid	2·02
Fluorine	0·90
Lime	47·65
Magnesia	0·30
Alumina	1·47

Oxide of Iron		2·71
Combined Water, Organic matter, &c.	By diff.	6·35
		100·38
Less Oxygen for Fluorine		0·38
		100·00

* Equal to Phosphate of Lime .. .. 78·59
† Equal to Carbonate of Lime .. .. 4·59

The next is an average analysis of 200 cargoes made in Europe on behalf of buyers and sellers :—

ARUBA PHOSPHATE.

	Per cent.
*Phosphoric acid	35·88
Lime	48·00
Oxide of Iron and Alumina	3·72
Silica	1·48
Undetermined matter... ...	10·92
	100·00

* Equal to Phosphate of Lime .. .. 78·31

Out of 200 cargoes the maximum determination of phosphate was 81·20 per cent and the minimum 75·75.

Such figures speak for themselves, and all conversant with the properties of phosphate will clearly see in the Aruba phosphate a valuable commodity for manure manufacture.

The foregoing analysis may be taken as a fair average representation of the phosphate that has been exported from Aruba by the Aruba Phosphaat Maatschappy since the formation of the Company. It is quite impossible for the quality to differ much from the preceding on account of the thorough intermixture, inseparable from the system of excavation and loading.

The regularity of the results, and the foregoing average of 200 analyses, clearly disprove some misleading statements appearing in one or two works published a few years ago in the United Kingdom. The Aruba phosphate is represented as an inferior article, but as the books were published before any organisation existed for the exportation of phosphates from the island of Aruba, the results quoted must have been obtained from defective samples, and the information supplied to the compilers founded upon an erroneous basis. In August, 1879, an experimental cargo was shipped from Aruba to England by the *Lillesand*, which yielded 78·26 per cent of tribasic phosphate of lime. The regular exportation began in August, 1881, and the first cargo when analysed yielded the following results :—

		Per cent.
*Phosphoric acid	... ...	36·38
Lime	... ...	48·27
Oxide of Iron	... ...	1·68
Alumina	... ...	3·02
Silica	... ...	1·62
Undetermined matter...		9·03
		100·00

* Equal to Phosphate of Lime .. .. 79·42

Nearly 100,000 tons have since been shipped, and the quality has varied very slightly, as the average analysis of 200 cargoes alluded to above plainly proves.

When sampling mineral phosphates much care is required to obtain fairly representative samples. The Company's plan in Aruba is to take a mixed quantity from every truck sent to the vessel. The bulky sample is afterwards passed through a Marsdon's stone-breaker and subdivided until a convenient quantity for the laboratory is obtained. In this manner concordant results are secured from fair average samples, with the numerous check analyses made weekly of all the phosphate found. When sampling vessels unloading, small samples should be carefully avoided. Mineral phosphates frequently differ as much in quality as appearance, and fairly representative samples can only result when a considerable quantity from different parts of the vessel has been thoroughly mixed and subdivided with such patience and care as a casual observer might consider superfluous.

Concerning the suitability of Aruba phosphate for manure manufacture we are able to adduce indisputable testimony. Its value for the manufacture of superphosphate is almost too well known to require comment; but to those unaccustomed to it the following reports may be of interest :—

(COPY.)

"Wiesbaden, 11th October, 1883.

"MR. G. M. BAUER, London.

"With your favour of 29th August I received a sample of Aruba phosphate marked—

"'417 tons Aruba Phosphate, ex *Mary Evans*, 21/4/83. Also a sample of Superphosphate made therefrom in August, 1883, marked "Sample of Superphosphate made from Aruba Phosphate only in August, 1883."—(Signed) JAMES GIBBS AND CO. and p.p. G. M. BAUER.

"'Both samples sealed—

J. G. and Co. and G. M. Bauer, London.'

"Agreeably to your wish the samples have been subjected to a very careful chemical examination. The results I lay down as follows :—

"The Aruba Phosphate represents in the unpulverised state hard lumps of a yellowish grey tint, and in the pulverised state an extremely fine yellowish grey powder.

"100 parts of the same contain—

"A. In the state of moisture in which I received the unpulverised sample—

	Per cent.
Water at 100° C....	3·54
Dried substance at 100° C....	96·46
	100·00

"B. In the dried state (at 100° C.)—

	Per cent.
*Phosphoric acid	35·77
Sulphuric acid	1·74
Carbonic acid	1·89
Fluor	2·86
Lime	47·62
Magnesia	0·30
Alumina	1·64
Oxide of Iron	2·00
Silica insoluble in acid ...	1·33
Combined Water...	5·27
Alkalies, Organic Matter, and Loss	0·78
	101·20
Less Oxygen for Fluor ...	1·20
	100·00

* Equal to Tribasic Phosphate of Lime .. 78·09

"C. 100 parts of the Phosphate contain, therefore, in the air-dry state in which I received the unpulverised sample—

	Per cent.
*Phosphoric acid	34·50
Sulphuric acid	1·68
Carbonic acid	1·82
Fluor	2·76
Lime	45·94
Magnesia	0·29
Alumina	1·58
Oxide of Iron	1·93

Silica insoluble in acid	1·28
Water of combination at 100° C.	5·08
Water at 100° C....	3·54
Alkalies, Organic Matter, and Loss	0·75
	101·15
Less Oxygen for Fluor	1·15
	100·00

* Equal to Tribasic Phosphate of Lime .. 75·32

"The Aruba Superphosphate represents a fine, light yellowish brown powder, scarcely moist, and of little smell. 100 parts contain—

	Per cent.
Phosphoric acid soluble in Water ...	17·08
,, ,, insoluble in Water...	0·87
Sulphuric acid	31·06
Lime	24·55
Magnesia	0·15
Kali and Natron	trace
Oxide of Iron and Alumina	1·85
Silica insoluble in acid	0·92
Moisture, combination, and small quantity of Organic Matter	23·52
	100·00

"The results of the analysis may there fore be put down as follows :—100 parts of the Superphosphate contain—

	Per cent.		Per cent.
$CaOSO_3+2Aq$...	66·78		
Basic Phosphate of Lime ...	1·90	= Phosphoric insol.	0·87
$2HO,CaOPO_5$...	7·43	Containing Phosphoric acid soluble... ...	17·08
$2HO,MgOPO_5$	0·82		
$3HO,PO_5$	16·62		
Total Phosphoric acid			17·95
Oxide of Iron and Alumina ...	1·85		
Silica insoluble in acid... ...	0·92		
Moisture and small quantity of Organic Matter	3·68		
	100·00		

"Therefore 100 parts of the Superphosphate have been manufactured of 52·03 parts of Aruba phosphate, with 36·98 hydrate of sulphuric acid, and the corresponding quantity of water.

"By this 95·15 per cent of all phosphoric acid have been rendered soluble in water, and 4·85 per cent have remained insoluble. These proportions are even found in a superphosphate which has been kept for months.

"The Aruba Phosphate appears, therefore, to be a very suitable material for making superphosphate, because the phosphoric acid contained in it may be transformed almost completely into a state soluble in water, and because it also remains in this state during the storing of superphosphate. The fact that the superphosphate made of it contains only 17 per cent soluble phosphoric acid can be no reason to call it less suitable for manufacturing purposes, always provided that the price is in proportion to the contents of phosphoric acid soluble in water.

"Yours truly,

"(Signed) Dr. R. FRESENIUS."

To fully prove the good quality of Aruba Phosphate for manufacture of superphosphate, we append a report by Aug. Voelcker, Esq.

(COPY).

"London, July 14, 1883.

"G. M. BAUER, Esq.,

"Dear Sir,

"I have the pleasure of sending you herewith analysis of a sample of superphosphate, which you inform me was made entirely of Aruba Phosphate.

"This superphosphate was in an excellent dry and finely-powdered condition, and evidently had been made some time ago, for it was in a well matured condition. I mention this specially because certain raw materials containing much oxide of iron and alumina, after having been made, with sulphuric acid, into superphosphate, and storage, go back as it is called, that is to say, after having been kept for a short time, they yield considerably less phosphoric acid soluble in water than they do when first manufactured. This evidently is not the case with the manufacture of superphosphate from Aruba Phosphate.

"You will notice that the sample which you sent me for analysis contains nearly 18 per cent of phosphoric acid soluble in water, and only about three-fourths per cent insoluble in water, and as this superphosphate was in a beautiful mechanical condition, and well matured, you have here a clear proof that the soluble phosphoric, if it has gone back at all, has done so only to a very small extent. My examination further shows that Aruba Phosphate (which, as far as my present experience goes, is remarkably uniform in composition) is an excellent phosphate for the production of concentrated fine and dry superphosphates of a light yellow colour, resembling closely superphosphates made in part from phosphatic guanos, and technically known as guano-coloured superphosphate.

"The colour of superphosphate made from Aruba phosphate I find is due to organic matter, as in the case of guano-coloured superphosphate, and not to oxide of iron. There is nothing in the colour of superphosphate worth consideration; still, as a matter of fact, guano-coloured superphosphates are held in favour by most purchasers.

"There is no difficulty whatever in producing fine, dry, and in all respects excellent high grade superphosphate from Aruba phosphates provided the latter is reduced to the finest impalpable powder, which is often neglected by manufacturers. As it is now almost the universal custom, abroad at all events, to sell superphosphate on the basis of a fixed rate for each unit per cent of phosphoric acid soluble in water, or per unit per cent of soluble phosphate of lime, I can see no reason whatever why the soluble phosphoric acid in a concentrated superphosphate containing 18 per cent of phosphoric acid soluble in water, should not be quite as valuable per unit as in a superphosphate containing 20 per cent of phosphoric acid soluble in water, the condition as to dryness, &c., being the same in both cases. Whether a superphosphate contains 18 or 20 per cent of soluble phosphate, in either case the manure has to be diluted with dry ashes or earth by the farmer before he can apply it with advantage to the land, and as long as the consumer pays at a given rate per unit per cent of soluble phosphoric acid, it makes, in my judgment, not the slightest difference whether he buys an 18 or 20 per cent superphosphate, provided the mechanical condition of superphosphate is equally good in both cases.

"I need scarcely say that if Aruba Phosphate can be bought at a rate which enables the manufacturer to produce 18 per cent superphosphate at a somewhat lower price than higher priced raw material yielding 20 per cent superphosphate, he will be in a position to benefit the consumer by giving him a share of the advantage of having bought his raw materials under favourable conditions.

"Yours faithfully,

"(Signed) AUG. VOELCKER."

It will be seen from the preceding analyses that the superphosphate is of good quality, and the remarks by Voelcker on soluble phosphates going back will be read with interest, as showing that Aruba superphosphate has remarkably good keeping qualities.

The foregoing analyses amply disprove the exaggerated objections cherished by many manure manufacturers, against even small percentages of iron and alumina. The amount of the latter constituent, when properly determined, rarely exceeds 4 per cent, so that any defence or explanation with regard to Aruba phosphate is uncalled for.

Without much digression, however, we express our opinion that the difference in values attached to soluble and reduced phosphates is much exaggerated. When soluble phosphates are applied to the land a large proportion of the soluble phosphates are immediately reduced by the basic oxides in the soil.

Facts speak louder than words, and the best testimony that Aruba phosphate is well suited for the manufacture of first class manures is adduced by the preceding analyses, and the favour with which it has been received since first exported, and the continuation of same favour to the present time.

The Aruba Phosphaat Maatschappy congratulate themselves on the success that has attended their business transactions, which must be primarily due to the satisfaction the phosphate has given.

The facilities for loading at Boca St. Nicolas, Aruba, are second to none in the West Indies. From Cerro Colorado the waggons are drawn to the pier by locomotives, and the phosphate tipped directly into the vessel; 400 to 500 tons may be loaded per day, and the vessels, when ready, are drawn out to sea by a steam tug belonging to the company, and kept for that purpose only.

Excellent water may be had at a mere nominal cost, and captains universally agree that their vessels are loaded in Aruba with convenience and despatch.

Besides phosphate, some agricultural products are exported from Aruba. The aloes, generally known as Curacoa aloes, are mostly grown in Aruba, and constitute one of the principal products here. Ground nuts too are exported from Aruba, and are much appreciated for their superior quality. In the United States it is known as the "pea-nut," in the West Indies as "pindas nut," and in Brazil under the name of "amendoum." In English cities they are generally known as "monkey nuts."

Dr. Muter, after giving the following analysis of ground nut meal, urges its more general use as an important article of food :—

Moisture	9·60
Fatty matters...	11·80
Nitrogenous compounds (flesh-formers) ...	31·90
Sugar, starch, &c....	37·80
Fibre	4·30
Ash	4·60
	100·00

The oil is used for cooking, rheumatic affections, and lighting, and the roasted seeds sometimes as a substitute for chocolate. When raw the seeds possess a somewhat harsh odour, but when properly roasted they have a very agreeable flavour, and are held in high esteem. Beans, divi-divi, salt, and dried fish are also sent from Aruba to Curacoa for transhipment to other ports.

The general agents of the Company, Messrs. Isaac and Samuel, 22, Great Winchester Street, London, E.C., will always be glad to furnish abundant evidence of the trustworthy quality and value of the Aruba Phosphate, and can conscientiously recommend it for all purposes of manure manufacture.

SPECIAL MANURES AND THEIR USES.

SINCE the introduction of manufactured manures, about the year 1840, the demand for special manures has rapidly increased in proportion to the growing and continually increasing appreciation of manurial matters, and during the intervening period more consideration has been devoted to the elucidation of the principles upon which agriculture depends. In earlier times, when land was plentiful and cheap, lands were abandoned on the first signs of exhaustion, and though I am fully aware that the same practice exists in some of our colonies to day, in other places where land is less plentiful and cities have been built, it has been found impracticable to remove far from them to carry on cultivation.

When land has been exhausted it requires many years of fallow or special manuring to restore it to its original fertility, and though animal and vegetable manures were first used and found valuable, the quantity was too small and the volume inconveniently bulky for universal use. The value of mineral manures was discovered, and the constituents of manufactured compounds from bones, guanos, and mineral phosphates have been found to be the same as exist in all manures and in the substances of all plants; so that by supplying the necessary constituents deficient in the soil, the fertility of the land is preserved or re-established.

The quantities of bones, guanos, and all fertilising refuse substances are totally inadequate to supply agricultural requirements, and mineral phosphates have thus supplied the much needed source of phosphate of lime.

If it were not for the supplies of mineral phosphates that have been utilised of late years, the gradual absorption of native guano would now have placed the price of artificial fertilisers almost beyond the farmer's reach. The adoption of manufactured manures is one of the many important events of modern times, and agriculture has been stimulated and developed as the result. By the application of chemistry, enormous strides have been made, and with the assistance that science affords to the manure manufacturer, and agricultural experiments, a sure and enlightened basis for the fertilisation of crops has been established. The experiments conducted at the Rothamstead experimental farm at Herts, founded by Sir John Bennet Lawes for the sole purpose of investigation, have succeeded in dispelling many of the clouds that in previous years made agriculture mysterious.

Before the year 1840 chemical manures were comparatively unknown, and the only substances used were salt, bones, ashes, lime, and manufacturers' refuse, and although all these substances are more or less valuable, the commencement of experimental farms and the introduction of Peruvian guano are epochs in the world's history that mark the commencement of a decided and sure understanding of the structure upon which the successful pursuit of agriculture rests.

When bones were first introduced they proved of great utility to the farmer; but now the soluble superphosphate is much preferred on account of the rapidity of its action, thus securing a quicker return for the outlay and a persuasive apparency of its beneficial action. Five hundredweights will quadruple a crop of turnips, amd is nearly equal to twelve tons of farm-yard dung.

In proportion to the quantities of phosphates required in commerce, the supply of bones, as previously stated, is comparatively small, and the increasing scarcity and deterioration in the quality of the guano from the Cincha islands has induced capitalists and chemists to search extensively for fresh substitutes capable of yielding similar results. The utilisation of mineral phosphates was thus a timely necessity, in order to meet the fast growing demand for phosphatic manures. When guano was first introduced agriculture was much benefitted, for in addition to about 20 per cent of phosphate of lime, there is always more or less ammonia, and that is the most valuable constituent. Peruvian guano formerly contained as much as 18 per cent of ammonia, but that quality has long since been exhausted, and the general quality now rarely contains more than 4 per cent, except in a small proportion, in which it rises to 12 per cent, but this quality is scarce and decreasing, if not already exhausted.

The price of ammonia salts and nitrates is now so low that they can be compounded with superphosphates in suitable proportion to suit all requirements, and artificial guanos thus compounded give every satisfaction.

The concentrated character of most artificial manures particularly adapts them for application in localities where cartage of more bulky fertilisers would be inconvenient, and doubtless with a little further development and investigation will be more and more appreciated as they become more intelligently compounded for colonial as well as European crops, and better adapted to foreign climates.

Most English farmers are already familiar with the great advantages to be secured by the use of artificial phosphates carefully mixed with nitrogenous and cinereal substances for particular purposes, and high rents and expensive labour, together with keener competing foreign production, have made it absolutely necessary to get the largest possible return from his lands.

The colonial planters of Africa, India, Ceylon, and the West Indies, however, have not the facilities for securing information regarding their crops that the English and Continental farmers have, and artificial fertilisers to them are very expensive; nevertheless, manures for exportation are rapidly increasing. When more decisive facts from carefully recorded experiments are secured in connection with tropical crops, many of the present difficulties the planters have will disappear. It is a pleasing fact that better cultivation and manuring is finding favour abroad, and with the planting community the question of manure is undoubtedly an all-important one, and the quantity required for export must necessarily increase if colonists are awakening to the fact that at present their labours in agriculture are very much in the dark.

It is really surprising to see the progress that has been made of late years for the purpose of investigation in agriculture. From an address by Dr. Gilbert before the Chemical Section of the British Association some years ago, I see that no less than 122 experimental farms were then in existence. It may seem a little digressive from the immediate subject of this paper, but I will quote a few figures from the speech referred to, believing that any information affecting the sale of manures will be of interest to manufacturers and vendors of manure materials, and equally so to the buyer, as showing what the application of science to agriculture has already done in other countries.

"Before 1840 several illustrious men had contributed valuable facts relative to the food and structure of plants; but in 1840 Liebig's memorable works were published in answer to a request submitted to him by a committee of the British Association. Confining attention to agricultural researches, it may be observed that about the year 1843—that is very soon after the appearance of the works in question, there was established the Chemico-Agricultural Society of Scotland, which it is said was broken up after it had existed five years because its chemist, Professor Johnson, was unable to find a remedy for the potato-disease. Shortly after this the Highland Agricultural Society of Scotland appointed a consulting chemist. Somewhat later the Royal Agricultural Society of England did the same, and later still followed the Chemico-Agricultural Society of Ulster. Lastly, the very numerous experimental stations which have been established, not only in Germany, but in most Continental states, owe their origin directly to the writings of Liebig. The movement seems to have originated in Saxony, where Stockhardt had already stimulated interest by his lectures and writings.

"After some correspondence in 1850—51 between the late Dr. Crucius and others on the one side and the Government on the other, the first so-called experimental farm was established near Leipsic in 1851—52. In 1877 the twenty-fifth anniversary of the foundation of the institution was celebrated at Leipsic, when an account, which has since been published, was given of the number of experimental stations then existing, and of the subjects which had been investigated. From that statistical statement we learn that in 1877 there were in the various German states 74, in Austria 16, in Italy 10, in Sweden 7, in Denmark 1, in Russia 3, in Belgium 3, in Spain 1.

Besides the afore-mentioned 122 stations on the continent of Europe, the United States are credited with one and Scotland with one.

It is stated that the investigation of soils has been the prominent object at sixteen of them ; experiments with manures at twenty-four ; vegetable physiology at twenty-eight ; animal physiology and feeding experiments at twenty ; vine culture and wine making at thirteen ; forest culture at nine ; and milk production at eleven.

Others, according to their locality, have devoted special attention to fruit culture, olive-culture, and the cultivation of moor, bog, and peat land ; the production of silk and the manufacture of spirit and other products."

Private workers have also contributed largely to our present store of knowledge on these matters. So much for the machinery ; but what of the results achieved by all this activity.

Mention of the Rothamstead station has been omitted in connection with the work of which Dr. Gilbert's services are well known.

The following are a few particulars I gather from a report of the doings there :—

The station was established by Sir John Bennet Lawes, who commenced experiments with plants in pots in 1834 ; but the foundation of the station may be said to date from 1843. To record the details of its growth would make this paper much too long. It has been maintained entirely by its founder, and he has further set apart a sum of £100,000 and certain areas of land for the continuation of agricultural investigation after his death.

In 1854—55 a new laboratory was built by public subscription of agriculturists as testimony of their appreciation of its value.

Sir John Lawes, I believe, was the original introducer of superphosphate of lime for agricultural uses.

The afore-mentioned experimental places were in existence in 1877, so that I doubt not during the last decade others not enumerated will have been established.

Government and experimental farms exist in Madras, and a strong desire was exhibited in Natal preceding 1883 for a Council of Agriculture there. The colony had suffered the almost total loss of its extensive coffee plantations from the devastating work of a coffee borer. My own observations, however, led me to believe that the system of cultivation was unsatisfactory, and rendered the coffee trees specially liable to disease of any kind. A Council of Agriculture with an experimental farm under the control of experts could have studied the subject very differently to individual efforts, and the planters appeared anxious for such establishment. The bill was passed in the Legislative Council by a large majority, but for some reasons best known to the Governor himself, he advised the Queen not to approve of it.

There is a growing desire for manures in the colony, and I doubt not the quantity consumed at present is much less than it will be a few years hence. The establishment of Councils of Agriculture to collect and publish statistics on all subjects affecting agricultural interests, and institutions to direct and control investigations on the compounding, uses, and special applications of manures, are no less in the interests of all connected with the manure manufacture than of the agriculturist himself—their interests are interwoven and alike.

The manufacturer can only compound his manures by the enlightenment he receives from the application of scientific control, and the maximum benefit can only be the product of actual demonstration in practice.

Liebig's theory, founded upon the principle that the composition of the ash of a plant indicates what is required in the manure, is only true where a soil is absolutely exhausted of some one or more constituents, and cannot indicate what manure to use in an economical aspect.

Why one soil will yield much more than another is sometimes very difficult to decide from analyses, and cases are frequent where two soils (analysed with the greatest care) with nearly the same composition give very diverse returns. Actual and continuous experiment can be the only guide to manure compounders as a trustworthy basis for special manures.

The preceding remarks refer to the value of information supplied by experimental farms; but some information required by the user of a more simple kind might be supplied by the manufacturers themselves.

I have reason to know that in many cases the use of manufactured manures in the hands of farmers does not produce the maximum monetary return that might result if more detailed instructions were supplied by the manufacturers themselves, and particularly when exported for use by planters in the colonies, who have had little experience in such matters.

In an article in the Natal "Mercury" the editor said "it seemed a lottery whether the planter threw his money away or not, there was so much adulteration and fraud in the manure trade." I mention this to show the want of confidence that prevails.

Agriculturists generally are not sufficiently familiar with concentrated mixed manures, that appear to them to cost such forbidding prices, forgetting the fact that 1 ton may be equal to 20 tons of compost, stable, or kraal dung.

Manufacturers' catalogues are usually full of analyses, prices, and valuation tables, but a large proportion of those for whose particular use the catalogues are published know little or nothing of what the analyses mean. If the compilers of the catalogues I mention would never omit to furnish the buyers with some simple particulars to govern the application, much more confidence in the compounds would be engendered, and a monetary result that the manufacturer himself would indirectly reap. For a few years I had the opportunity of moving amongst agriculturists on the East coast of Africa, and often heard what seemed justifiable objections against imported manures that I sometimes found difficult or impossible to dispel. The want of confidence on the part of buyers and would-be buyers too often arises from the unsuitability of the fertiliser or its improper and extravagant use, and when the expected benefit is not secured all the fault is attributed to the manure, whereas the failure in many cases was due to misapplication.

A frequent story recorded is that So-and-so has tried some for which he paid £16 or £20 per ton, and failed to recover the outlay—so they say they have no faith in artificial manures. We cannot wonder that such is the case, because the transaction merely means so many tons of soluble phosphate or cane food, said to contain so much nitrogen and alkaline salts; but embraces no consideration of the soil, crop, or the climate wherein it is applied, and a mystery always seems to prevail as to how it ought to be used. On one large sugar estate, under the guidance of a more than usually enlightened manager, I saw a gang of coolies carefully scraping away the soil that covered the roots of cane ratoons, and then applying about four cwts. per acre of a good phosphatic manure, containing about seven per cent of nitrogen. The gentleman told me that the plants always seemed sickly for a few weeks afterwards, and I was not surprised. When a manure with a strong acid reaction and a large amount of ammonia salts was applied in a soil very deficient in lime, and in almost immediate contact with the roots, the plants must necessarily suffer a relapse.

In many tropical regions the crops are grown on steep hillsides which are subjected to very heavy and continued rains during the wet seasons, and under such conditions it is an extravagant policy to apply manures (the most valuable constituents of which are soluble) in the conventional method of three or four cwts. per acre at one dose.

Such is undoubtedly the common practice, and consequently a questionable benefit ensues. With colonists who have to pay heavy prices, all the more care and economy is necessary.

In the English climate it is undoubtedly true that a much higher value is attached to soluble manures than to those which are insoluble, principally because the agricultural season in England is limited to a few months of the year, and the soluble compounds are thus immediately available for the plant at the particular period when any saving in time is of so much importance. Hence the great advantages to be secured from the soluble manures. Farmers are naturally anxious to reap immediate results, and therefore apply manures that the plant can immediately assimilate; but a large amount of the unabsorbed material that was soluble, and is possibly in the land at the end of the season, will be lost by drainage during the winter months.

Many of our colonial climates are eminently stimulating, and plant food is more particularly required in contradistinction to stimulating manures. A quotation from an article by Dr. Phipson in the "Sugar-cane" will explain very clearly what I mean. "The difference between a manure and a stimulant does not appear to be well understood, though there is evidently the same difference between them as there is between food and medicine. The effects of the one are permanent, or extend over a considerable time; the effects of the other are ephemeral, and rarely extend beyond the period of one season. The full benefits of a manure will not, in general, be felt the first year; sometimes not for two, three, or more seasons; and in Liebig's introduction to his "Organic Chemistry" will be found some instances in which six or seven years have elapsed before a soil has been able to recover its pristine fertility. When, however, a thoroughly good manure is discovered, one that suits both the soil and the plant cultivated upon it—which is no very easy matter—then, in the course of a season or two, the land becomes remarkably prolific.

"With a stimulant, on the other hand, such as sulphate of ammonia or nitrate of soda, ingredients which form only a small portion of complete manures, the effect is immediately apparent (unless, indeed, the soil is hopelessly barren), but next season nothing occurs."

Many crops, such as sugar, coffee, tea, &c., are standing from year to year, and with heavy rainfall the land is often deficient in lime, and prone to acidity. In such cases it is very desirable that insoluble nitrogenous manures be used in conjunction with superphosphate, bone-meal, &c., so that the effect may be not only immediately available, but gradual and lasting. Such manures as rape cake dust, dried fish meal, and finely-ground dried blood, are all suitable and cheap, that would prove very valuable for intermixture with manures for export.

It is true that, in some cases where plants are flagging, that the immediate effects of ammonia salts or guano may be of special service when used with caution, but such application should be clearly understood.

I have known superphosphates containing 20 per cent of ammonia salts applied to coffee trees, standing on land particularly deficient in potash, produce a very detrimental effect. The trees made a lot of foliage, and appeared, for a few years, to have been much benefitted ; but afterwards the tree suddenly failed, and died. The manure was undoubtedly to blame, because of its unsuitability ; but such cases serve to nourish the opinion amongst many conversant with the fact, that imported manures are dangerous materials to deal with, and best avoided.

I merely mention these cases among many I remember, to illustrate the ignorance that operates prejudicially against the manufacturer's and agricultural interest, and which I think might be materially diminished by the compilation of some simple instructions for the use of their buyers.

Concerning the suitability of special constituents for particular crops we have yet very much to learn, and with respect to colonial crops we seem to be comparatively in the dark.

Manufacturers are not familiar with the characteristics of different climates and soils; but, whilst admitting the foregoing facts, the best information procurable might be given to mitigate, if possible, the deplorable misuse to which good manures are often subjected.

What components to incorporate for different crops is of primary importance to the manure compounder ; but in the absence of exact details from actual trial in every case, the composition can only be considered approximately satisfactory in a general way, or on the same basis that medicines are prescribed for new patients by the medical profession, because they have previously proved effective in other cases.

WHEAT AND OATS.

For cereal crops such as wheat, oats, barley, maize, millet, &c., it is well known amongst intelligent farmers that nitrogenous manures, such as nitrates, ammonia salts, guano, and dung, are more effective than all others. This conclusion has been proved conclusively by abundant experience. On firm dry soil containing the mineral elements necessary, a crop of wheat may be doubled by the aid of 200 lbs. of ammonia salts, or its equivalent, 275 lbs. of nitrate of soda per acre.

The results of continued experiments for many years are that nitrogen, in any of its ordinary combinations, is the most efficacious addition for the growth of wheat and other cereals, and yields, with these crops, the largest return.

Of course all corns require phosphates and other materials for due development, and such are generally supplied ; otherwise, on soils of pcor or moderate quality, exhaustion might rapidly ensue if the ordinary course of rotation be not adopted, or phosphates and alkali salts applied.

The following mixtures I copy from the Rothamstead experiments as having proved exceptionally beneficial for wheat and oats over a series of years on the same ground. The soil is described as a heavy loam containing flint; it rests on clay with a chalk subsoil about six feet from the surface. The whole of the produce is removed from the soil. By this mode of proceeding the permanent effect of each system of manuring becomes apparent, and exhaustion or accumulation is made evident.

For cereals :—

Sulphate of Potash	200 lbs.	16·8 per cent.
Sulphate of Soda	100 ,, ...	8·4 ,,
Sulphate of Magnesia	100 ,, ...	8·4 ,,
Ammonia Salts	400 ,, ...	33·6 ,,
Superphosphate	3½ cwts.	32·8 ,,
		100·0

The average for twenty-six years on the same ground was 33¼ bushels, and the average of oats for five years was 59 bushels. On unmanured plots it was 13½ bushels and 19⅞ respectively. The quantity of alkali salts would be approximately supplied by an equal weight of good kainit, and then the composition would be nearly equal to ⅓ each of kainit or Stassfurt salts, sulphate of ammonia, and superphosphate. We have then a typical manure for use on the same land continuously. It is more economical, however, in practice, to reap the benefit produced by rotation of crops, and when a crop of wheat follows a crop of turnips that have been well dressed with superphosphate, a top dressing with nitrates or ammonia salts gives a good return ; but that plan means gradually impoverishing the soil of alkali salts, which the preceding compound would avoid. The superphosphate or insoluble manures may be advantageously applied in the autumn, and the ammonia salts or nitrates as a top-dressing in the spring.

BARLEY.

For barley the following gave the most produce, for an average of twenty-six years yielding 45¾ bushels of dressed corn per acre, and the unmanured plots yielding 18⅜ :—

Superphosphate 3½ cwts.,	=	66·3 per cent.
Ammonia Salts 200 lbs.	=	33·7 ,,

It is remarked that the addition of superphosphate to the ammonia salts exhibits a more distinct value than is the case with wheat, and that the addition of alkali salts is of no apparent value. The writer I am quoting suggests that the shorter rooted and shorter lived barley has less capacity than wheat for obtaining phosphates from the soil, and that barley seems to have a greater capacity than wheat for supplying itself with alkalies, but such is not proved, as the considerable effect of the alkalies on the wheat crop appears to be due to some secondary action.

Of all the nitrogenous manures applied to wheat and barley, nitrate of soda is apparently the most effective. Another fact to be remembered is that an amount of nitrogenous manure merely sufficient for a wheat crop will be excessive for a barley crop grown under similar circumstances.

MAIZE.

Maize always requires well manuring. On good soils 80 to 100 bushels may be obtained per acre, and the soil must necessarily be well sustained in consequence.

I have no detailed record of produce obtained under different systems of manuring, but have known excellent results from the use of a mixture resembling that given for wheat and oats. The stalks and dead leaves are usually trodden into the ground by cattle at the end of the season, and those that remain are burnt and the ashes spread over the land. With the maize crop, ashes, gypsum salt, or some supply of alkali salts are very necessary. Salt at the rate of 3 or 4 cwts. per acre strengthens the stalks of maize, wheat, oats, barley, &c., and is very beneficial sown broadcast.

On account of the heavy rains in tropical regions it is advisable to apply about a quarter or one-third of the ammonia salts when planting, and the other portion about six weeks afterwards, when the cultivation commences. Excessive doses of manure, too, sometimes prove disadvantageous by stimulating the growth of such large plants to such an enormous extent that the passage of air amongst the crop is retarded, and other inconveniences occur.

MILLET.

Millet does well with similar treatment to maize.

Nitrogenous manures for cereals are the specific to ensure successful crops; but in all cases it is advisable to use at the same time superphosphates and alkali salts.

MEADOW LAND.

Meadow land may be made to give an abundant yield by suitable manuring, and when all the constituents removed by a crop are returned to the soil more permanent fertility is assured.

In a ton of good hay there are 150 lbs. of mineral matter and 25 lbs. of nitrogen, equivalent to forty-six and a half pounds of ammonia, which is of great value in promoting the growth of all grasses, but has a prejudicial effect upon leguminous herbage. Clover that may be amongst the grass is practically destroyed, and the crops obtained from nitrogenous manures are almost purely graminaceous; but when manured with mixed cinereals the produce is mostly leguminous. The following is the compound giving the maximum yield continuously at Rothamstead :—

Sulphate of Potash	300 lbs.
Sulphate of Soda	100
Sulphate of Magnesia ...	100
Superphosphate...	392
Ammonia Salts	800

The average yearly produce was 109 cwts. of hay.

How to improve impoverished grass land in the most economical manner, and how to manure so as to maintain the fertility of the soil and retain a mixed herbage of good quality, is often a serious question with the farmer. Though the preceding manure gives a heavy crop of hay, still, on account of the pernicious influence nitrogenous manures have on clovers, some modification is advisable. One way to supply the constituents removed by the crop is by scattering ashes and superphosphate over the meadow after every crop of hay has been removed. In this manner a meadow will yield a heavy crop of mixed herbage for a long time. The ashes will furnish the necessary potash and alkaline salts which favour, to a remarkable degree, the growth of clovers and broad leaved plants so desirable in grass crops. Nitrogenous manures of all kinds favour the growth of narrow-leaved grasses, as cocksfoot, rye grass, &c., producing a rank and succulent herbage. With liberal dressings of ammonia salts clover is practically destroyed, even when an abundance of potash is simultaneously supplied.

Superphosphate decidedly improves the action of ammonia salts, and the addition of potash still further increases the beneficial effect.

Nitrogenous manures increase the quality, and phosphatic and potash manures improve the quality.

Meadow hay removes more potash than crops of wheat, &c., and having shorter roots with which to assimilate potash, it is not surprising that potash manures should produce a considerable benefit. If grass is continually mown for hay, care must evidently be taken to supply the land with the lime and potash which the crop removes, and which it is less capable of obtaining for itself than any other crop on the farm. When superphosphates and potash salts are so cheap, it is a very easy matter to keep the meadows in a good state of productiveness.

Together with superphosphates and potash salts, barn-yard manure and home-made composts constitute a favourable source or nitrogen, and thus the fertility is improved and maintained.

CLOVERS, &c.

(Clovers, Beans, Peas, Tares, &c., and other Leguminosæ).

For these crops potassium salts appear to have a most astounding influence, and unless the land be particularly deficient in lime, excellent crops may be obtained by a dressing of kainit or wood-ashes alone.

The indifference of the bean, clover, and other crops belonging to the order Leguminosæ to nitrogenous manures, and the considerable increase obtained by supplying ash constituents only, and the fact that the crop cannot be repeated indefinitely with success on the same land, even with ample manuring, are all points in which it greatly differs from the cereals and grasses. With 300 lbs. of sulphate of potash alone 97½ cwts. have been obtained, and with mixed cinereals 92¾.

A mixture of equal weights of kainit, superphosphate, or gypsum is a convenient and profitable application. Ammonia salts are actually pernicious to clovers, but add to the weight of the crop by a stimulating action on the grass the crop contains.

TURNIPS.

Turnips give good results with 2½ to 3 cwts. of superphosphate, but the addition of ammonia salts, and more so nitrates, shows a marked improvement, almost doubling the produce.

Alkali salts appear to be of very little benefit, as this crop seems to have the most difficulty in assimilating phosphoric acid. On partially exhausted soil nitrogenous manures produce hardly any effect, unless accompanied by phosphates, while phosphates applied alone are capable of largely increasing the produce.

SUGAR-BEET, MANGEL WURZEL, &c.

Sugar-beet and Mangel Wurzel are quite different to turnips, for while the latter are so much benefitted by superphosphates, the latter has little or no effect with sugar-beet and mangels.

Beet-root is also quite indifferent to manures supplying alkalies, but the crop appears nearly trebled by about 550 lbs. of nitrate of soda.

Mangel wurzel closely resembles beet-root, and will be therefore similarly benefitted by the same manures.

POTATOES.

Potatoes are best manured with a compound like the following :—

Kainit	25 per cent.	
Superphosphate... ...	50	,,
Ammonia salts	25	,,

It is well known that potatoes thrive best on light dry sandy soil. If the soil be loamy and rich in nitrogenous organic matter, the above quantity of ammonia salts may be reduced to one-half with advantage. A composition recommended by J. Coleman to the members of the York Chamber of Agriculture seems highly beneficial :—

Superphosphate	2½ cwt.
Kainit	1½
Potassium Chloride	¾
Sulphate of Ammonia	¾
Rape dust	¾
	6½ cwts. per acre.

The latter mixture was sown broadcast after the land had been treated with 9 tons of fold yard dung. Excellent results are said to have been obtained.

SUGAR-CANE.

Sugar-cane responds well to good cultivation ; but the fertilisers require selecting with great care, otherwise the result at the mill may be very disappointing.

If canes be forced exceptionally by stimulants on poor soils the juice contains a relatively small proportion of crystallisable sugar, and is prone to acidify with unusual rapidity. On the other hand, if the canes be well supported by an ample supply of good plant food from the soil or applied as manure, and light admitted between the rows, the canes will give an excellent return of crystallisable sugar.

A good manure for cane is the following :—

Rape cake	20 per cent.	
Ammonium Sulphate .	20	,,
Superphosphate	40	,,
Kainit	20	,,

Sugar-cane lands often become impoverished from lime, possibly partly due to damaged canes acidifying, and the faintly acid drainage waters may thus gradually dissolve the carbonate of lime, which is lost. An occasional dressing of ground limestone, marl, or lime, to neutralise the acidity produced by decaying vegetable matter, or a liberal dressing of ashes is very advantageous. In chalky soils superphosphate may be used with advantage, together with nitrogenous manures and alkaline salts ; but if lime be deficient in the soil a superphosphate with too much acidity should be avoided. Bone-meal, precipitated phosphates, alkali salts, and ammonium sulphate, rape cake dust, or dried blood should be used, and the phosphate applied in small quantity only.

COFFEE AND TEA.

Coffee and tea are crops that are subject to trying conditions of growth, on account of the long time the trees stand on the same soil. The crops themselves are not exhausting, but the powerfully oxidising influences of a tropical sun produce rapid exhaustion if the soil is not suitably nourished. Coffee and tea require sustaining manures in contradistinction to stimulants. If coffee receives excessively stimulating manures, the trees make an abundance of leaf and the wood seems soft and delicate and liable to disease.

I don't know of any systematic experiments on manuring coffee with different mixtures; but have seen some estates in Natal that were doing very well with an annual dressing of superphosphate containing about 12 per cent of sulphate of ammonia. It was a clayey soil and not particularly deficient in potash; but that it was the most ecomonical fertiliser I very much doubt. I should prefer the following:—

Dried Blood	25 per cent.
Steamed Bones	50 ,,
Kainit	25 ,,

The foregoing would be a lasting and valuable mixture for coffee or tea.

Twice the weight of rape cake dust could be substituted for the dried blood, and bone dust for the steamed bones.

A small addition of sulphate of ammonia or nitrate of soda and superphosphate may be used as a top dressing at the beginning of the season or before the rains commence.

Tea might receive the following with advantage:—

Dried Blood...	50 per cent
Bone-dust	40 ,,
Potash salts (Kainit) ...	10 ,,

Here again a small top dressing of ammonia salts and superphosphate before the rains commence would repay the outlay abundantly. Under the stimulating influences of tropical climates small and more frequent applications of manures are certainly the most satisfactory and economical, and when the constituents of the manure are in an insoluble condition, temporary exhaustion of the tree's natural productive powers is avoided.

How fertilisers are to be used must necessarily depend on the nature of the crop, condition of the land, situation, climate, solubility or insolubility of the manure, and many other questions.

However simple the application may seem, it is nevertheless a fact that much manure is very inappropriately applied and lost.

The quantity most economical will depend mostly on the farmer himself, previous cropping, and what the land requires. My preceding observations on tropical crops are the results of my own observations, but I very much regret not having systematic details in each particular case.

It is a very difficult matter to persuade tropical agriculturists to experiment with new products whatever they may be. A prevailing prejudice against what is known as theory operates prejudicially against any investigation, and considering the blunders and waste that often accompany the misuse of manures, the caution cannot be said to be altogether unjustifiable. When the results anticipated are not secured at the first trial, a second attempt is rarely thought of. A quarter of a century since science was considered infallible, and its apparent conclusions were put into opposition with practical experience too stubbornly, and consequently much harm was done in that way, and the application of science to agriculture by many is now more or less mistrusted, for farmers could not appreciate theory which in some cases so strongly contradicted results the value of which they had proved by careful practice.

Too much reliance on soil analyses and Liebig's mineral theory have doubtless had much to do with mistaken ideas and faulty remedies for agricultural difficulties.

Now it is found that practice, not theory, must guide the formation of chemical rules, and on that basis experimental farms under State aid should receive the support of all connected with manures and agriculture. Until we have more complete information we must content ourselves with such as we have; but we require much more knowledge of the various fertilising matters we are in the habit of using, and the predominating conditions and requirements of particular crops, before any reasonably well informed scientific man can venture to give practical directions as to the system of cultivation and manuring to be adopted in different localities and climates. Experimental farms can alone provide the information required, and their permanency and efficacy can only be assured, and established on a permanent basis, by government aid, or support from societies, manure manufacturers, and farmers.